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# STUDIES ON SOME BIOLOGICAL ACTIONS OF THE WEED, *ANAGALLIS ARVENSIS* L. IN RELATION TO ITS DIGESTIVE CAPACITY IN *SCHISTOCERCA GREGARIA* (FORSK.)

A.M. El-Gammal*1*, G.Z. Taha*1*, M.F. Harb*1* and M. Rizk*2*

1. Locust Res. Dept. Plant Protection Res. Inst., Agric. Res. Center, Dokki, Egypt.
2. Vegetable Acarology Res. Dept., Plant Prot. Res. Inst. Agric. Res. Center, Dokki, Egypt.

ABSTRACT

*Anagallis arvensis* L. is an annual winter weed found in fields and gardens. It's biological actions on *Schistocerca gregaria* (Forsk.) as fresh diet and extracts with different solvents were investigated.

Permanent feeding of the *1st*, *2nd*, *4th* and *5th* instar nymphs of *S. gregaria* on the fresh plant resulted in prolongation in their nymphal duration. Mortality percentages during these instars were; 80.0, 16.7, 60.0 and 75.0 for each instar, respectively. These percentages ranged from 100 to 30 for the residual effects of its fine powder extracts.

The density of the cell type as well as the importance value (I.V.) in the faeces of the treated *1st* and *2nd* instar nymphs indicated that the toxic action of *A. arvensis* depends upon the digestive capacity of *S. gregaria* to the plant cells.

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## INTRODUCTION

Screening for bioactive compounds in plants with potential for insect control has recently attracted great attention due to the environmental problems which have been created by the intensive use of insecticides (Freedman *et al.*, 1982).

Many years ago, th neem tree, *Azadirachta indica* A. Juss, was demonstrated to posses antifeedant properties against *S. gregaria* (Pradhan and Jatwani, 1968). The primary antifeedant compound of the neem seed called azadirachtin was isolated by Butterworth and Morgan (1971) and chemically characterized by Nakanishi (1975).

More recently azadirachtin has been found to possess in addition to antifeedant properties, insect growth regulators (IGR) activity, oviposition deterrency and effects on insect fecundity (Schmutterer, 1990).

Prospecting for similar properties in indigenous plants, El-Gammal *et al.* (1988) found several wild plants in the Eastern desert of Egypt and the Delta Tokar of the Sudan on which the desert locust would not feed.

The present study aims to investigate the toxic action of the annual winter plant, *Anagallis arvensis* against the desert locust, *Schistocerca gregaria* (Forskal).



## MATERIALS AND METHODS

### The plant:

*Anagallis arvensis* L. commonly called the scarlet pimpernel is an annual winter weed with red or blue flower on long stalks. The fruits are smooth, globe-like capsules containing many three angled, brown seeds. The mature plant is low growing and many-branched. The plants are found in the fields and gardens and the seeds are found to be toxic to small animals (Rizk, 1989).

Fresh plants were collected from clover fields in Fayoum Governorate. The plants were used directly in feeding trials as a fresh diet or by contact with the residue of crude solvent extract prepared from dried powdered plants as mentioned later in some details.

Groups of 60 nymphs each of 1*st* and 2*nd* instars were fed sufficient amounts of the fresh plant daily and held in wooden cages 30X30X30 cm.

Groups of older nymphs were treated similarly. Thus, 30 4*th* instar and 40 5*th* instar nymphs were fed fresh foliage continuously. Control insects were fed on the usual food of *Trifolium alexandrinum*.

Uneaten plants were removed daily and the faeces were collected for the following examinations:

Determination of plant cells:

The methods of microscopic examination developed by Ghabour *et al.* (1982) were used to examine the faeces of the desert locust. The faeces were collected soon after feeding and examined to determine their content of plant cells as an indicator of locust digestive capacity.

A. In fresh plant:

1. Plant sample was placed in a mixture of alcohol and glycerin (95:5) for 4-5 hrs. to soften the cell walls.
2. The sample was then crushed by hard object (blunt end of a glass rod) to help penetration of chemicals.
3. Javelle water of 18° strength (sodium hypochlorite) was added to the sample for decolouration, then was left for 4-5 hrs.
4. Formalin (1:9) drops were added to remove the javelle crystals.

B. In insect faeces:

1. One pellet of faeces was placed on a slide and covered by drops of the alcohol/glycerin mixture for 5 hrs. This procedure was replicated 10 times.
2 The sample was crushed by hard object as above.



3. Javelle solution was added and the slide was left 4-5 hrs.
4. A formalin drop (1:9) was added to remove the javelle crystals.
5. The slide was covered and examined.

Calculation:

The occurrence of plant cell types was tabulated as a percentage or by an importance value (I.V.) for each cell type, based on the formula of Beals (1960).

Preparation of plant extracts:

Whole plants of *A. arvensis* were collected, rinsed in tap water an allowed to dry at room temperature. Dried plants were ground with a house hold grinder and 10 to 20 grams of fine powder was extracted with 100 ml of hexane, ethanol, chloroform, petroleum ether, acetone or ethyl acetate in a conical flask, separately.

The extraction of plant powder was performed for 48 hours at room temperature with occasional agitation. Following filtration, the extracts were tested for toxicity to *S. gregaria* by contact with the extract residue in Petri dishes.

Evaluation of the contact toxic action of *A. arvensis*:

Ten milliliters of each extract were pipetted into Petri dish, then was allowed the solvent to evaporate at room temperature.

Ten nymphs of *1st* and *2nd* instar as well as 5 nymphs of *4th* and *5th* instar were confined on the thin layer films of each extract in the Petri dishes. At least three replicates of each extract were performed and the percentage mortality was recorded after 24 hours of exposure. Control groups were confined in untreated Petri dishes.

## RESULTS AND DISCUSSION

Biological effects of the fresh plant *Anagallis arvensis* on *S. gregaria*:

1. Effect on the nymphal instar duration:

Table (1) shows that, the sustained feeding of the nymphs of *S. gregaria* on plant *A. arvensis* prolonged considerably duration of the nymphal instars.

Developmental intervals were increased to 7.8, 10.0, 6.7 and 17.7 days for *1st*, *2nd*, *4th* and *5th* instar nymphs, respectively fed permanently on the fresh plant compared to developmental times of 5.6, 3.8, 4.6 and



10.4 days, respectively when fed on *Trifolium alexandrinum*.

2. Toxic effect of the fresh plant:

Table (1) indicates that permanent feeding of the nymphs on of *S. gregaria* on the fresh plant of *A. arvensis* caused 80.0, 16.7, 60.0 and 70.0% mortality to *1st*, *2nd*, *4th* and *5th* instar nymphs, respectively, while mortality did not mostly exceed 10% in the control nymphs fed on *T. alexandrinum*.

Table (1): Effect of feeding on fresh plant, Anagallis arvensis L. on the nymphal instars of *Schistocerca gregaria* (Forsk.)

| Instar | Treatments | % Mortality during | | Total % of mortality | Duration in days |
|---|---|---|---|---|---|
| | | Feeding | Ecdysis | | |
| *1st* | Treated (60)* | 80.0 | 0.0 | 80.0 | 7.8 |
| | Control (20) | 25.0 | 0.0 | 25.0 | 5.6 |
| *2nd* | Treated (60) | 16.7 | 1.7 | 18.4 | 10.0 |
| | Control (20) | 10.0 | 0.0 | 10.0 | 3.8 |
| *4th* | Treated (30) | 60.0 | 0.0 | 60.0 | 6.7 |
| | Control (20) | 5.0 | 0.0 | 5.0 | 4.6 |
| *5th* | Treated (40) | 75.0 | 10.0 | 85.0 | 17.7 |
| | Control (20) | 0.0 | 0.0 | 0.0 | 10.4 |

* Number of used nymphs.

3. Toxic action of the plant extracts:

Table (2) shows the toxic effect of the plant extracts against the two early nymphal instars using

different solvents of hexane, ethanol, chloroform, petroleum ether, acetone and ethyl acetate.

When the weights of 10 grams each of fine powder of *A. arvensis* were separately extracted in 100 ml of each solvent and tested against 1*st* instar nymphs, the mortality percentages were 40, 60, 40, 60, 60 and 60, respectively, compared to 15% mortality in the untreated controls. Doubling dose to 20 grams of plant powder using same volume of same solvents, induced remarkable increasing in mortality percentages with hexane, acetone and ehtyl acetate, they were 60, 70 and 100%, respectively compared to the control.

Table (2) also shows that, 10 grams of the fine powder extracted with 100 ml of each pre-mentioned solvents resulted in 40, 40, 50, 40, 60 and 90% mortality, respectively against the 2*nd* instar nymphs, while these percentages of mortality were 30, 20, 40, 60, 40 and 50 when the extracts were prepared from 20 grams plants powder using the same solvents. Mortality in control insects of 2*nd* instar did not exceed 10% in both cases.



Table (2): Contact toxicity of organic extracts of Anagallis arvensis L., against the first two nymphal instars of *Schistocerca gregaria*.

| Solvent used in extraction | % Mortality | | | |
|---|---|---|---|---|
| | 1st instar nymphs* | | 2nd instar nymphs* | |
| | 10 gm. | 20 gm. | 10 gm. | 20 gm. |
| Hexane | 40 | 60 | 40 | 30 |
| Ethanol | 60 | 50 | 40 | 20 |
| Chloroform | 40 | 30 | 50 | 40 |
| Pet. ether | 60 | 50 | 40 | 60 |
| Acetone | 60 | 70 | 60 | 40 |
| Ethyl acetate | 60 | 100 | 90 | 50 |
| Control | 15 | 15 | 10 | 10 |

Ten nymphs of each instar were confined on a t' s layer film of the extract in Petri dishes.

In conclusion, feeding of the nymphs of *S. gregaria* on the fresh plant *A. arvensis* indicate( that this plant may have some biologically action properties which resulted in prolongation of the nymphal durations of *S. gregaria*. Also, this plant exhibited significant toxicity when was fed as fresh plant or by exposure the insects to its crude extracts prepared with different solvents.

These obtained results are in agreement with El-Gammal and Ghoneim (1989) and El-Gammal *et al.* (1990), they found several wild plants with biologically active

properties against *S. gregaria*. Moreover, the findings of the present study agree with studies by Freedman *et al.* (1982) who stated that the ethanol extract of seeds of *Treuris nudiflora* was toxic to *Acalymma vittatum* (F.) and gave 100% control of *Manacanthus stramineus* (Nitzsch) after 28 days. Also, El-Nahal *et al.* (1989) found an insecticidal properties in *Acorus calamus* against a wide variety of insects.

The prolongation of nymphal stadia induced by permanent feeding on the fresh plant of *A. arvensis* may be due to neuro-endocrine action on the moulting cycle of these nymphs. In this respect, Coudriet *et al.* (1985) stated that, azadirachtin (the active compound in *Azadirachta indica* tree) acted as an antiecdysteroid in whitefly, *Bemisia tabaci* (Genn.), perhaps via a neuro-endocrine control of ecdysteroids.

4. The importance value of *A. arvensis* to *S. gregaria*:

The density and importance value (I.V.) of the different cell types of *A. arvensis* was estimated in the whole plant as well as in the faeces produced by the treated nymphs

Table (3) shows that the density of all cell types in *A. arvensis* was generally higher than in the control



diet *T. alexandrinum*, as the branched cells did not occur in *A. arvensis* and that plate and straight hairs were absent from *T. alexandrinum*.

The importance value (I.V.) of all cell types of *A. arvensis* showed obvious increases over *T. alexandrinum*, as well as in the faeces of the fed *1st* instar nymphs on each plant. This means that, the digestibility of the plant cells of *A. arvensis* was lower than those of *T. alexandrinum*, which induced a high density of the cell types of *A. arvensis* in the faeces of the *1st* instar nymphs (Table 3).

Also, Table (3) shows that the permanent feeding of *A. arvensis* through the *1st* and the *2nd* instar made the *2nd* instar more sensitive to this plant. Thus, the density as well as I.V. of all cell types of this plant was lower in the faeces of the *2nd* instar nymphs than the *1st* instar one (Fig. 1). It reveals that the *2nd* instar nymphs consumed only a little amount of *A. arvensis* which was not enough to kill them as indicated by data in Table (1) revealing the toxic action of the fresh plant, where the mortality percent during the *2nd* instar was lower than during the *1st* one.

Reviewing of this investigation suggests that the toxic action of *A. arvensis* may depend upon the digestive capacity of *S. gregaria* nymphs to the plant cells.

Table (3): The density of different cell types and the importance value (I.V.) of *Anagalis arvensis* in *Schistocerca gregaria*.

| Cell types | Density of cells | | | | | | The importance value (I.V.) of cells | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | In plant | | In the faeces of locust nymphs of | | | | In plant | | In the faeces of locust nymphs of | | | |
| | | | 1*st* instar fed on | | 2*nd* instar fed on | | | | 1*st* instar fed on | | 2*nd* instar fed on | |
| | T.* | A.** | T | A | T | A | T | A | T | A | T | A |
| Transfer hair | 9.3 | 66.7 | 13.0 | 18.4 | 25.8 | 27.5 | 31.6 | 252.0 | 55.6 | 81.3 | 180.8 | 128.2 |
| Xylem element | 3.8 | 42.7 | 5.6 | 16.1 | 18.3 | 2.2 | 14.2 | 161.3 | 18.7 | 64.9 | 80.8 | 8.3 |
| Branched hair | 4.5 | 0.0 | 3.7 | 0.0 | 5.8 | 0.0 | 17.0 | 0.0 | 15.0 | 0.0 | 71.7 | 0.0 |
| Long hair | 1.5 | 2.0 | 2.2 | 3.8 | 8.3 | 1.7 | 6.6 | 7.6 | 9.2 | 16.7 | 36.7 | 5.8 |
| Uniform hair | 1.8 | 5.0 | 9.9 | 0.8 | 28.7 | 2.9 | 6.6 | 18.9 | 42.4 | 3.4 | 122.1 | 10.1 |
| Short thick hair | 2.3 | 2.7 | 5.5 | 3.2 | 1.3 | 3.9 | 9.8 | 10.1 | 23.2 | 13.7 | 5.3 | 28.9 |
| Plate hair | 0.0 | 12.3 | 0.0 | 0.1 | 0.0 | 2.0 | 0.0 | 46.6 | 0.0 | 0.2 | 0.0 | 8.2 |
| Straight hair | 0.0 | 6.3 | 0.0 | – | – | – | 0.0 | 23.9 | 0.0 | – | – | – |

* T. = *Trifolium alexandrinum*.
** A. = *Anagalis arvensis*.



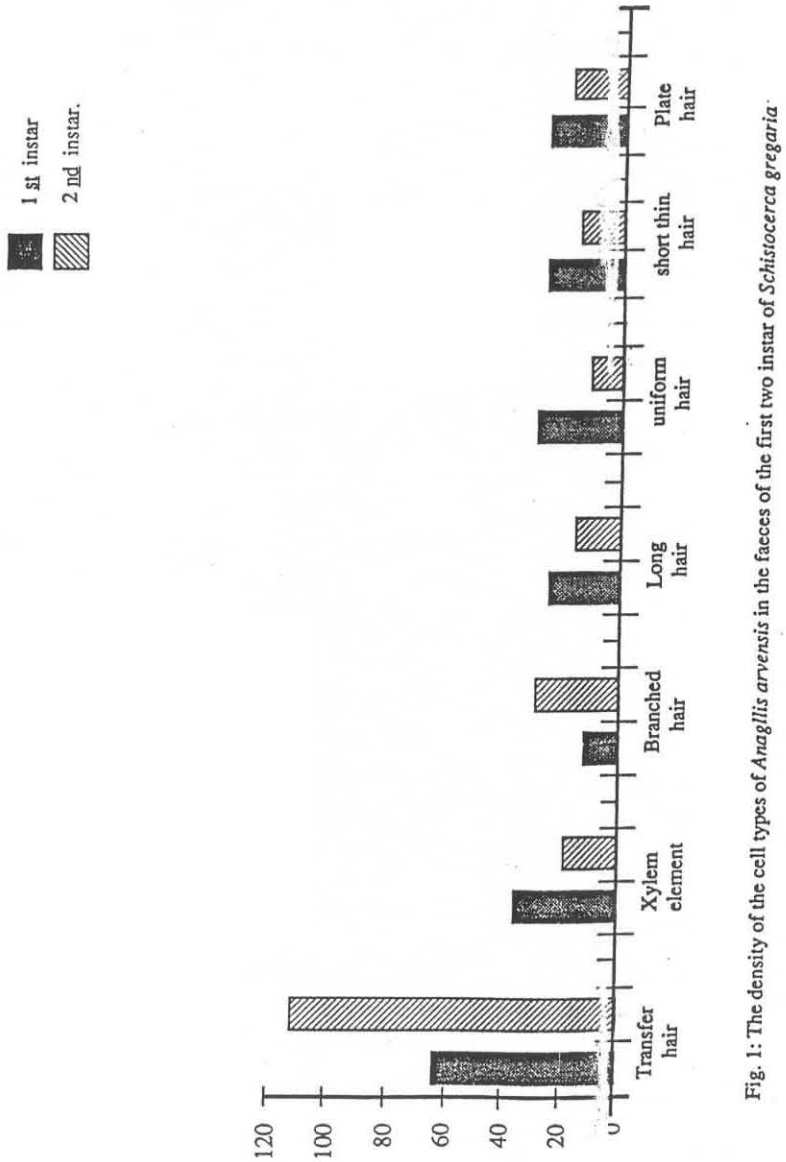


Fig. 1: The density of the cell types of *Anagllis arvensis* in the faeces of the first two instar of *Schistocerca gregaria*

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# دراسات حول التأثيرات البيولوجية لحشيشة أنجلس آرفنسس وعلاقتها بكفاءة هضم الجراد الصحراوى لهـــا

ابراهيم محمد الجمال ، جمال زكى طه ، محمود فهمى حرب
مارجريت عدلى رزق
معهد بحوث وقاية النباتات ـ مركز البحوث ـ الزراعية ـ الدقى

حشيشة "الانجلس آرفنسس" حشيشة حولية توجد بمعظم الحقول والحدائق ، تم دراسة تأثيرأنها البيولوجية كغذاء طازج وكذلك أختبرت المستخلصات بالمذيبات المختلفة للنبـــات الجاف المطحون ضد الجراد الصحراوى .

أدت التغذية المستمرة على هذه النباتات الى اطالة الاعمار اليرقية الخمسة للجـــراد الصحراوى ، كما نتجت نسب متفاوتة من موت هذه الحوريات وهى ٨ ٪ ، ١٦,٧٥ ٪ ، ٦٠ ٪ ، ٧٥ ٪ لكل من الاعمار الاول والثانى والرابع والخامس على حده . تراوحت هذه النسب بين ٣٠ ٪ الى ١٠٠ ٪ عند اختبار الاثر الباقى لهذه المستخلصات ضد حوريات العمرين الاول والثانى .

وبتقدير كثافة وتعداد أنواع الخلايا المختلفة لهذا النبات وأهمية هذه الخلايا وذلـــك بفحصها وتقدير تعدادها فى البراز الناتج من هذه الحوريات (العمرين الاول والثانـــى) للجراد الصحراوى أوضحت أن سمية هذا النبات تعتمد الى حدما على الكفاءة الهضمية لهـذه الخلايـــا .